DOCUMENT RESUME

ED 228 299 TM 830 219

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TITLE An Investigation of College Students' Academic Achievement Based on their Piagetian Cognitive Level and ACT Scores.
PUB DATE Apr 83
NOTE 20p.; Paper presented at the Annual Meeting of the American Educational Research Association (67th, Montreal, Quebec, April 11-15, 1983).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; *Age Differences; Cognitive Processes; *College Entrance Examinations; *College Students; Developmental Stages; Education Majors; Higher Education; Scores; *Sex Differences
IDENTIFIERS ACT Assessment; *Piagetian Stages

ABSTRACT

The purpose of this study was to determine if academic achievement differed among the Piagetian cognitive levels of teacher education students and if these differences interacted with sex, age, classification (e.g., freshmen, sophomores), or ACT scores. Sample for the study consisted of 670 students enrolled in a developmental psychology class. The results indicated that Piagetian scores differed according to sex and ACT scores but not classification or age; the four types of achievement (quizzes, projects, test, and total) differed according to Piagetian scores, sex, and ACT scores; all types of achievement except quizzes differed according to classification; and age was not related to achievement in any way. (Author)

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An Investigation of College Students' Academic Achievement Based on Their Piagetian Cognitive Level and ACT Scores

Presented to AERA

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April 11 - 15, 1983

Printed in USA

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Abstract

The purpose of this study was to determine if academic achievement differed among the Piagetian cognitive levels of teacher education students and if these differences interacted with sex, age, classification (e.g., freshmen, sophomores), or ACT scores. Sample for the study consisted of 670 students enrolled in a developmental psychology class. The results indicated that Piagetian scores differed according to sex and ACT scores but not classification or age; the four types of achievement (quizzes, projects, test, and total) differed according to Piagetian scores, sex, and ACT scores; all types of achievement except quizzes differed according to classification; and age was not related to achievement in any way.

An Investigation of College Students' Academic Achievement Based on Their Piagetian Cognitive Level and ACT Scores

College faculty have long been interested in the characteristics, such as sex and classification (freshmen, sophomore, junior, senior, graduate), that relate to their students' achievement. Although American College Testing (ACT) scores have traditionally been used as reliable indicators of academic success (1981), perhaps the cognitive level of college students also relates to their level of achievement in the college classroom. In the past two decades extensive research has been done on cognitive development, especially those ideas advanced by Jean Piaget. Research on Piaget's theory concerning the fourth stage, that of formal operations, originally used upper elementary and secondary students. Piaget (1972) found that formal operations emerged during early adolescence, 12 to 15 years of age, in his research population. Recent research with more diverse populations, however, has indicated that formal thought may not be attained until late adolescence, 15 to 20 years of age (Dale, 1970; Tisher, 1971; Kincheloe, 1972; Ball & Sayre, 1972; Karplus & Peterson, 1970). A number of researchers have reported that even many college freshmen have not yet attained all the characteristics of formal thought (Schwebel, 1975; Lovell, 1961; McKinnon, 1970; McKinnon & Renner, 1971).

Kuhn (1979) explains that the transition between concrete operations and formal operations is marked by a change from thinking dominated by reality to thinking dominated by possibility. At the level of concrete operations an individual is limited to concrete, empirically given data. In a classroom setting this might be exemplified by a student learning basic

facts but not being able to apply those facts to a new situation or to analyze their logical placement in a larger milieu. With the development of formal operations the given data form only one portion of a group of possibilities. Inhelder and Piaget (1958) indicate that this ability to isolate variables via an "all other things being equal" technique is one of the cognitive strategies that marks the emergence of the formal operational structure. Another is the systematic combination of elements, as found in the simple strategy of proportional reasoning. Only formal thinkers would be able to correctly utilize proportional reasoning to calculate which of the two sizes of a product, one 12 oz. and the other 16 oz., was the better buy.

Inhelder and Piaget (1958) assert that the growth of formal thinking is influenced as much by social factors as by maturation. Education as a social force can accelerate or retard this growth. If this is so, then it is of considerable importance to know the kinds of educational activities adolescents and young adults are required to perform.

These educational activities may be based on the kind of educational goals that the student is expected to achieve. Bloom in his Taxonomy of Educational Objectives (1956) identifies six major categories in the cognitive domain. The knowledge category, the lowest level of learning outcomes, includes recall of specific facts and appropriate information. Comprehension, the next highest level, involves the ability to grasp the meaning of material and represents the lowest level of understanding. The application category requires a higher level of understanding than those under comprehension and refers to the ability to use learned materials in new and concrete situations. The analysis category, requiring an understanding of both the

content and structural form of the material, demands an ability to break material into component parts so its organizational structure can be understood.

As these categories of learning outcomes increase in complexity, so the level of cognitive functioning may also need to increase. As Kuhn (1979) indicated, this underscores the "diminishing importance of transmitting to young people any particular body of scientific or technical knowledge and the increasing importance of assuring that they possess the cognitive strategies that will enable them to seek out and acquire knowledge for themselves." If cognitive level is influenced by the educational environment of an individual, perhaps the reciprocal is true--that cognitive level influences the learning or achievement that takes place in class. If this reciprocal is true, then cognitive level in addition to ACT scores should be used as an indicator of academic success in college.

Because adolescents appear to be reaching formal operations at a later age and because cognitive level may indeed influence what is learned in a classroom, this study investigated differences in academic achievement based on college student's cognitive level. Specific research questions included the following:

1) Do males and females differ in their Piagetian scores?

2) Do students with different classifications (freshman, sophomore, junior, senior, graduate) differ in their Piagetian scores?

3) Are ACT scores related to Piagetian scores?

4) Do students of various cognitive levels differ in academic achievement as measured through quizzes (knowledge category), projects (comprehension

and application categories), unit tests (comprehension, application, and analysis categories), unit tests (comprehension, application, and analysis categories), and total achievement (sum of all scores)?

5) Are there differences in achievement based on the interaction of Piagetian level and other factors such as sex, age, classification, and ACT scores?

Method

The sample of this study consisted of 670 midwestern university students enrolled in a beginning developmental psychology course of the teacher preparation program during the fall and spring semesters of the 1981-82 academic year. Approximately 25 percent of these students were male and 75 percent female. Of this sample 20 percent were classified as freshmen, 59 percent sophomores, 18 percent juniors, 2 percent seniors, and 1 percent graduate students. The vast majority of these students were teacher education majors, although a few had not yet declared a major. The composite ACT score mean of the students was 20.79 with a standard deviation of 4.51.

The total achievement score was composed of 1) six multiple-choice quizzes which required recall of developmental facts (knowledge); 2) two observation projects which necessitated translating, interpreting, predicting, and applying physical, cognitive, and psychosocial concepts and principles to a child or youth in a school situation (comprehension and application); and 3) three objective unit tests which measured the ability to grasp the meaning of the material, use material in new and hypothetical situations, analyze the relationship between parts, and recognize logical fallacies in reasoning (comprehension, application, and analysis). These categories are similar to those described by Bloom (1956).

Piagetian data were collected at the beginning of each semester using a paper and pencil instrument (Burney, 1974) consisting of twenty-one items to determine the students' cognitive level (concrete--score of 0-7; transition between concrete and formal--score of 8-13; or formal--score of 14-21). Items in the instrument identified abilities to use syllogisms, verbal analogies, proportional reasoning, and hypothetical reasoning. Information concerning sex and classification was obtained from students, and ACT scores were obtained from the students' files.

Results

The difference of Piagetian scores according to sex and classification was investigated through the use of a one-way analysis of variance. This analysis indicated a significant difference in Piagetian scores between males and females, F (1,652) = 8.15, $p < .005$. A one-way analysis of variance comparing Piagetian scores and classification showed no significant difference in the Piagetian socres of students from different classes, F (4,659) = 1.50, $p < .20$. See Table 1 for means and standard deviations of Piagetian scores by sex and classification. The relationship of Piagetian score with ACT total score was determined through correlation ($r = 0.52$) as well as the relationship of Piagetian score with age ($r = 0.03$).

Table 2 indicates the means and standard deviations of Piagetian groups, sex, and classification as they related to various types of achievement. Two-way analyses of variance (ANOVA) with Piagetian score and sex as independent variables and quizzes, projects, unit tests, and total achievement scores as dependent variables were computed. Additional two-way ANOVAs using the same dependent variables and Piagetian score and classification

as independent variables were also done. Table 3 provides a summary of analysis of variance for testing the significant differences in student achievement as it related to the above mentioned factors.

An analysis of covariance with Piagetian score and ACT total score was computed for quizzes, projects, unit tests, and total achievement. See Table 4 for a summary of significant differences in student achievement. The relationship of Piagetian scores, age, and total ACT scores to quizzes, projects, tests, and total achievement was further substantiated by an analysis of achievement score predictors. This final analysis involved a multiple regression. See Table 5 for the F ratios. In no case was age a significant factor, and ACT score was a more dominant predictor than Piagetian score.

Discussion

The Piagetian scores of this research sample, 30 percent of whom tested below the stage of formal operations, substantiated the findings of recent research. Table 1 points out that males had higher Piagetian mean scores than females. However, even though Piagetian scores were significantly related to the various categories of achievement and males did have the higher Piagetian scores, male achievement in each category was lower than that of females.

This phenomenon might be explained by the fact that males constituted only 25 percent of the total sample. In addition, multiple regression analyses indicated that Piagetian scores, ACT, and age constituted only 30 percent of the total variation in test and total achievement scores and even less in projects and quiz scores. This means that over 70 percent of

the variation in scores was due either to factors that were not investigated in this study or to errors of measurement.

Possibly a factor like motivation in a required education course is of greater importance than cognitive level. Perhaps males are not traditionally socialized to feel it important to understand how children grow and develop. A further investigation of these and other factors might explain lower male achievement in a beginning education course.

Further analysis indicated there is a trend of higher Piagetian score with increasing academic status, even though this trend was not significant. Graduates consistently achieved the highest scores in the various categories; they were followed by sophomores. This fact might be related to the type of class in which the study was conducted. The beginning developmental psychology course is typically taken by college sophomores who know they want to become teachers. Any graduates who take this course already have a B.A. in some other field and have not been satisfied with that area. Therefore, they come back to college with high motivation to obtain a teaching certificate and achieve at the highest level. Freshmen taking the course may not have had the background or experiences to be able to apply the concepts at more complex levels such as tests and total achievement. Juniors and seniors who take such a beginning course may be having some difficulty in deciding their major or career choice or they may have been unsuccessful in other majors. All of these possibilities might be the basis of further research.

A moderate but significant correlation was found in the relationship of Piagetian score to ACT total score. When an analysis of covariance using Piagetian score and ACT total score was conducted, it was found that ACT

was a significant predictor of student scores in each category of achievement. Piagetian scores made a significant difference only in the category of unit tests. This was further substantiated by multiple regression analysis. The conclusion could be drawn that students learn basic facts and are capable of lower-level comprehension whether or not they are formal thinkers. Tasks requiring higher-level analyses and reasoning, however, are better accomplished by formal thinkers. Perhaps college professors should be sure their students are capable of higher-level thinking before they expect students to perform accordingly in their classes.

In summary, this study found that college students are not all formal thinkers; that Piagetian level does influence student achievement, particularly if more complex thinking is required; that age and classification are not related to achievement in a beginning education class; and that sex as a factor of achievement is not readily explained. Future studies might well explore <u>how</u> Piagetian levels influence achievement as well as study how motivation relates to achievement and to Piagetian levels of thinking.

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TABLE 1

Means and Standard Deviations of Piagetian Scores
by Sex and Classification

	$\bar{x}$	SD
Sex		
male (167)	15.71	3.16
female (487)	14.93	3.00
Classification		
freshmen (134)	14.73	3.10
sophomores (390)	15.10	3.08
juniors (117)	15.32	2.92
seniors (15)	15.93	3.06
graduates (8)	16.75	3.81

TABLE 2

Means and Standard Deviation for Piagetian Scores, Sex, and Classification with Identified Dependent Variables

	Quiz		Project		Test		Total Achievement	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Piagetian Group								
Concrete	46.89	3.92	44.80	11.31	134.20	11.97	233.80	17.45
Transition	46.88	6.51	49.02	9.00	143.25	19.63	246.28	34.06
Formal	49.25	5.78	50.33	7.84	154.12	16.72	262.65	29.18
Sex								
Male	47.16	5.95	45.86	10.42	145.32	17.61	246.13	31.09
Female	49.06	6.05	51.31	6.81	152.89	18.26	261.93	30.77
Classification								
Freshmen	48.15	5.81	50.19	7.31	148.44	18.96	246.88	29.67
Sophomores	48.77	6.01	50.57	7.78	151.46	17.88	262.59	30.76
Juniors	48.26	6.53	47.72	9.67	149.92	18.25	252.43	31.48
Seniors	47.13	6.36	46.71	9.87	149.27	20.52	251.20	36.93
Graduates	51.62	5.29	53.12	5.51	171.00	13.44	279.25	17.70

Table 3

ANOVA Summary Table for Testing the

Significant Differences in Student Achievement Associated

with Piagetian Scores, Sex, and Classification

	Quizzes			Projects			Unit Tests			Total Achievement		
Source of Variation	df	MS	F	df	MS	F	df	MS	F	df	MS	F
Piaget - P	2	406.45	11.96***	2	252.78	4.16*	2	9293.55	31.60***	2	20719.36	24.81***
Sex - S	1	534.18	15.72***	1	3776.72	62.20***	1	8140.38	27.68***	1	37815.52	45.28***
P x S	2	3.05	0.09	2	436.82	7.19***	2	51.27	0.17	2	985.52	1.18
Error	641	33.98		641	60.72		641	294.13		641	835.17	
Piaget - P	2	353.00	10.14	2	184.65	2.86	2	8272.36	27.29***	2	17742.56	20.71***
Classification - C	4	28.62	0.82	4	250.77	3.89**	4	853.37	2.82*	4	6562.27	7.66***
P x C	6	19.12	0.55	6	119.27	1.85	6	151.06	0.50	6	350.26	0.41
Error	643	34.81		643	64.47		643	303.17		643	856.76	

* $p < .05$

** $p < .01$

*** $p < .001$

Table 4

Summary of Analysis of Covariance for Testing

Significant Difference in Student Achievement Associated

with Piagetian Score and ACT Score

	Quizzes			Projects			Unit Tests			Total Achievement		
Source of Variance	df	MS	F	df	MS	F	df	MS	F	df	MS	F
Piaget - P (main effect)	2	46.31	1.54	2	114.66	1.83	2	914.64	4.20*	2	961.62	1.46
ACT - A (covariate)	1	1759.17	58.44**	1	1061.69	16.91**	1	45290.98	208.22**	1	135575.83	205.98**
Error	498	30.10		498	62.79		498	217.52		498	658.22	

* $p < .02$

** $p < .001$

Table 5

Summary of Analysis of Variance

between Piagetian Score, ACT Score, and Age

and Identified Dependent Variables

	df	SS	MS	F
Quizzes				
Regression	3	1832.32	610.77	20.75*
Residual	492	14482.52	29.44	
Projects				
Regression	3	1177.32	392.44	6.53*
Residual	492	29590.28	60.14	
Unit Tests				
Regression	3	46730.76	15576.92	72.37*
Residual	492	105893.35	215.23	
Total Achievement				
Regression	3	136039.21	45346.40	69.26*
Residual	492	322120.59	654.72	

* $p < .01$